

## BELLCOMM, INC.

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SUBJECT: Apollo 9 Wind Constraints -  
Case 320

DATE: February 24, 1969

FROM: W. O. Campbell

MEMORANDUM FOR FILE

Figure 1 is a composite view of the Apollo 9 wind constraints. They are generally less restrictive than those for Apollo 8 (A-8), reflecting realignment of the Apollo Access Arm (AAA), better stack verticality, launch experience, and gradual availability of more data.

Tracking constraints imposed on A-8 by AAA misalignment and vehicle four-inch stack measurement (specification limit eight) have been markedly alleviated by minor AAA rework and 1.88 inch stack measurement. They are now about the same as A-9 vehicle bending moment values in Table 1 showing constraints during countdown.

Figure 2 shows wind and engine positional error in terms of holddown post clearance. The shaded area requires simulation for launch decision.

Pad abort, safe to 25 knots as for A-8, requires MSC graphical simulation at greater values to verify CM land impact horizontal velocity to be less than 54 feet per second. Dividing a parameter range into safe and simulation zones is standard practice.

The launch release criterion of  $81.5 \times 10^6$  inch-pounds is up  $5 \times 10^6$  from A-8. If bending moment instrumentation fails, launch is safe to 30 knots, requires wind profile simulation above 30 up to a 47 no-go. Figure 3 shows the February maximum and minimum one-hour probabilities of exceeding 30 and 47 knots. The six minute probabilities, important at T-6 minutes, can be estimated by taking 10 percent of the Figure 3 values.

The effects of two changing probabilities are reflected in the Launch Mission Rules Assessment Procedure Action/Notes to be followed if the  $81.5 \times 10^6$  value is exceeded after T-10 minutes. These Action/Notes are briefly:

(NASA-CR-104053) APOLLO 9 WIND CONSTRAINTS  
(Bellcomm, Inc.) 8 p

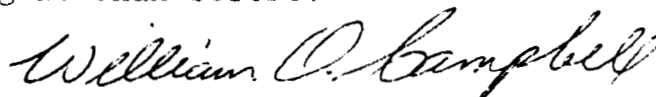
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notify ---; hold, recycle/resume ---; recycle ---; (after T-60 seconds) no action. The hold allows time to assess imminence of obviously worse winds, as in an approaching storm. As the resumed count approaches T-0, the probability of exceeding the  $81.5 \times 10^6$  value becomes smaller since exposure period approaches zero. Concurrently the risk associated with shutdown becomes higher, hence the note "no action" after T-60 seconds.

The 99 percentile wind rose in Figure 1 at 12 kilometers (maximum q) shows the February expectations to be less than the flight constraints, most of which are 5 to 30 percent less stringent than before.



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2032-WOC-mp

Attachments

Figures 1-3

Table I

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REFERENCES

1. "Apollo 9 Launch Mission Rules Wind Constraints," MSFC Memorandum 1-MO-MGR-69-8, January 28, 1969, MSFC Launch Mission Rule Input, p. 1-4.2 to 1-4.4 and graphs following.
2. "Saturn V Launch Vehicle Flight Dynamics Analysis, AS-504," D5-15509(F)-4, Boeing, January 20, 1969, p. 3-17.
3. "AS-503 Wind Restrictions - Case 320," Bellcomm Memorandum for File, W. O. Campbell, December 17, 1968.
4. TWX P272311Z, January 1969, from MSC to MSFC signed George M. Low.
5. Speer, Dr. F. A., 1-MO-MGR, MSFC, presentation to R. A. Petrone and others at Launch Mission Rules Review, KSC, January 30, 1969.
6. Kurtz, H. F., presentation notes at Launch Mission Rules Review at KSC, January 30, 1969, sheet "Summary of AS-504."
7. "Apollo 9 Launch Mission Rules Wind Constraints," MSFC Memorandum I-MO-MGR-69-9, February 5, 1969.
8. Recio, B. T., I-MO-R, MSFC, Conversations on February 12 and 18, 1969.
9. Rankin, T. O., I-MO-O, MSFC, conversations on February 10, 11, 12, and 20, 1969.
10. DeFife, J. E., ET25, MSC, conversation on February 11, 1969.
11. "Apollo/Saturn V Launch Mission Rules, Final," February 3, 1969, Change 1 dated February 17, 1969, pp. 1-11 and 2-77.

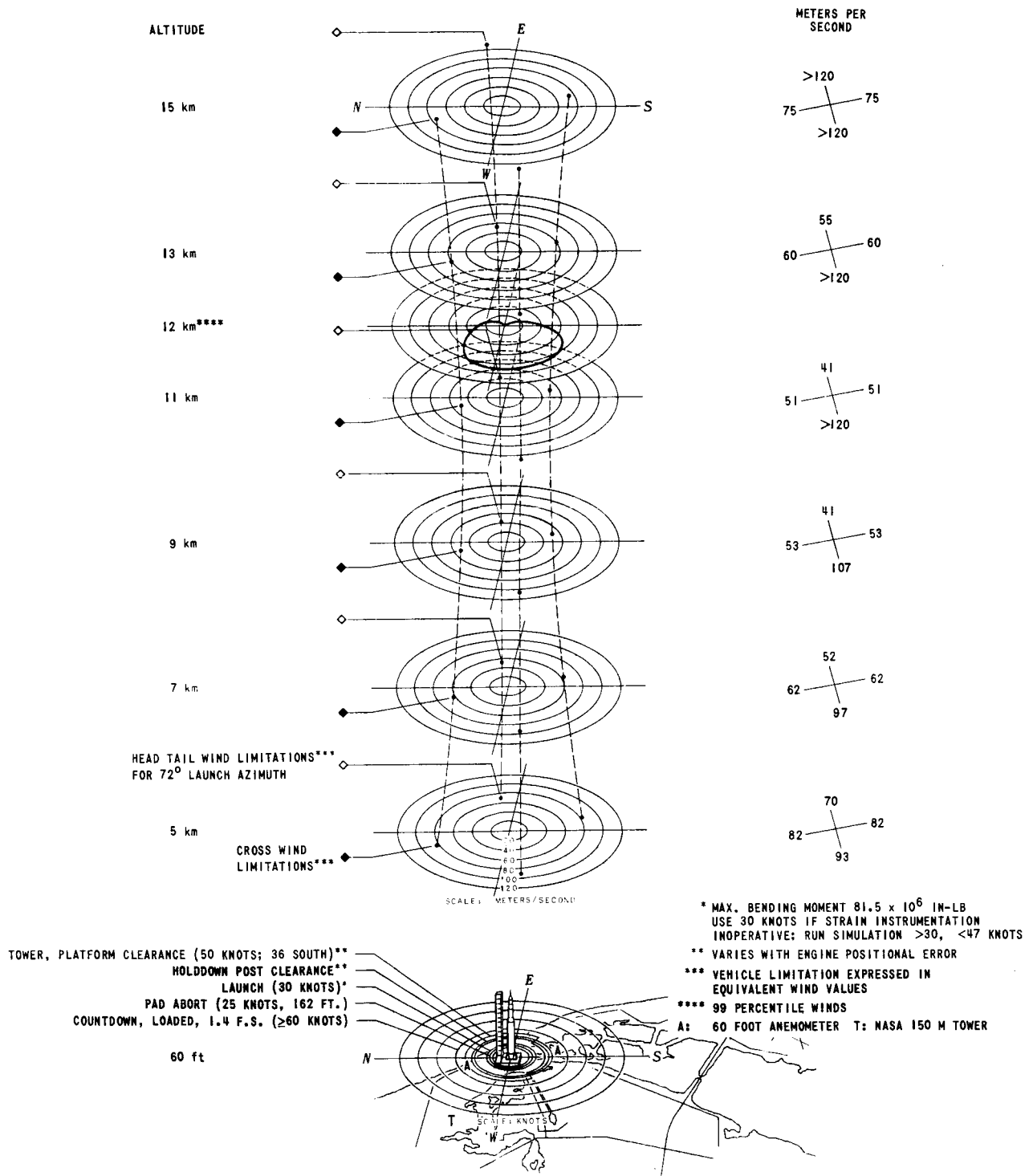
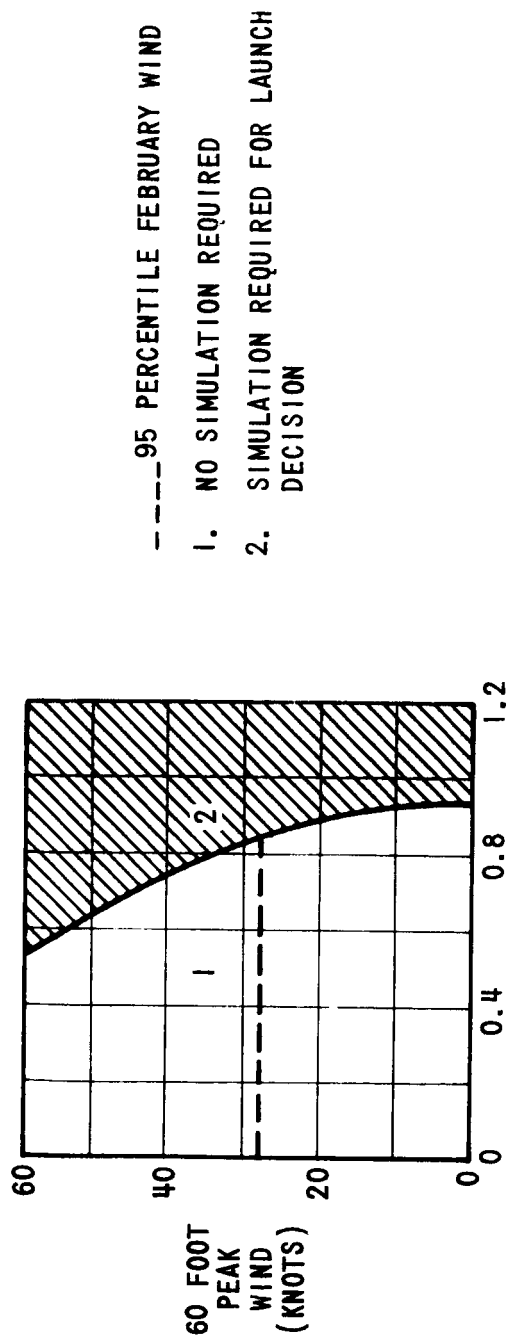


FIGURE 1 - APOLLO 9 WIND CONSTRAINTS



LEGEND:

0	+0.4	+0.8	+1.2	:	ENGINE YAW/	+ NORTH WIND
0	-0.4	-0.8	-1.2	:	"	+ SOUTH "
0	+0.4	+0.8	+1.2	:	"	PITCH + EAST "
0	-0.4	-0.8	-1.2	:	"	+ WEST "

ENGINE POSITIONAL ERROR (DEGREES)

FIGURE 2 - SURFACE WIND LIMITS FOR HOLDDOWN POST CLEARANCE

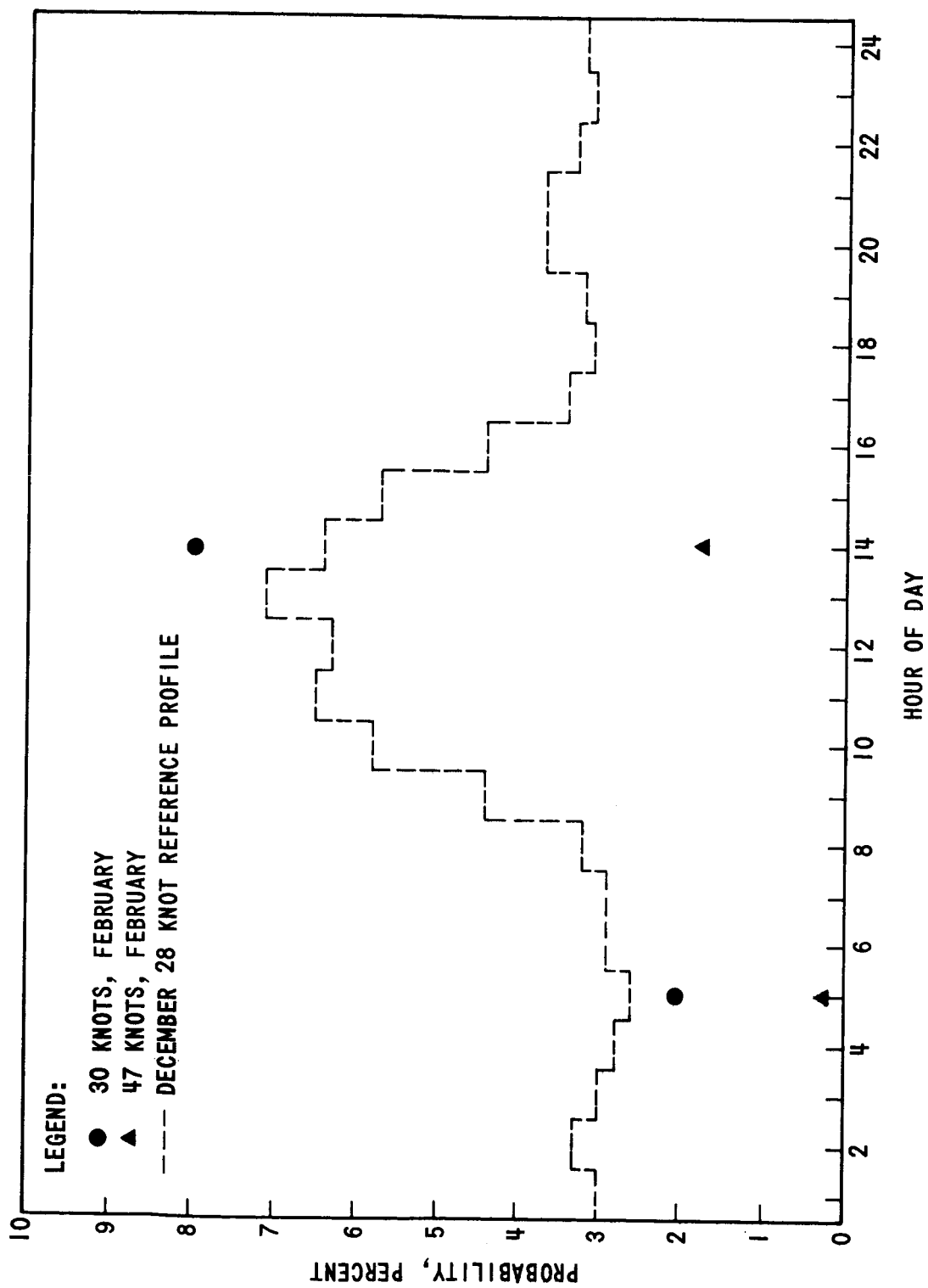


FIGURE 3 - MAXIMUM AND MINIMUM ONE-HOUR PROBABILITIES OF EXCEEDING 30 AND 47 KNOTS PEAK SURFACE WINDS, APOLLO 9 LAUNCH

TABLE I  
APOLLO 9 COUNTDOWN WIND CONSTRAINTS

	COUNTDOWN CONFIGURATION							CONSTRAINTS		
	S/F	LOX	LOX	LH <sub>2</sub>	LOX	LH <sub>2</sub>	DAMPER	KNOTS		10 <sup>6</sup> IN-LB
								AAA	S/V	AAA S/V
<u>MSS AT VEHICLE</u>	1.25	0	0	0	0	0	ON	>75.0	64.0	>218 175
MSS AT VEHICLE	1.25	0	0	0	0	0	OFF	≥29.2	30.0	≥110 145
<u>MSS REMOVED</u>	1.25	0	0	0	0	0	OFF	≥29.2	30.0	≥110 145
MSS REMOVED	1.25	0	0	0	0	0	ON	≥47.0	64.0	≥117 179
S-IVB LOX LOADED	1.25	0	0	0	100	0	ON	≥54.7	≥61.4	≥123 165
S-II LOX LOADED	1.25	0	100	0	100	0	ON	≥59.7	64.0	≥131 175
S-IC LOX LOADED	1.25	100	100	0	100	0	ON	≥62.7	64.0	≥135 173
S-II LH <sub>2</sub> LOADED	1.25	100	100	100	100	0	ON	≥64.0	64.0	≥137 173
S-IVB LH <sub>2</sub> LOADED	1.25	100	100	100	100	100	ON	≥64.0	64.0	≥173 173
VEHICLE LOADED	<u>1.40</u>	100	100	100	100	100	OFF	≥60.0	≥58.3	≥137 167
LAUNCH RELEASE								NA	≤30	NA ≤81.5

NOTES:

1. PRIOR LOADING OF S-IC RP 1, CSM CRYOGENICS, CSM/LM HYPERGOLICS, AND LM SHE.
2. SIGNIFICANT CHANGES IN CONFIGURATION UNDERScoreD.
3. AAA IS APOLLO ACCESS ARM. REMOVING AAA RAISES RESTRICTION TO S/V VALUE.
4. BENDING MOMENTS MEASURED AT VEHICLE STATION 790.
5. ASSESS HIGHER WIND PROBABILITY IF EXCEED 81.5 x 10<sup>6</sup> IN-LB AFTER T-6 MINUTES.
6. SIMULATION REQUIRED FOR LAUNCH RELEASE AT >30 KNOTS

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